

What is claimed is:

1. A focusing waveguide grating coupler using a leaky mode, comprising:

5 a substrate having a first refraction index  $n_1$ ;

a first core layer having a second refraction index  $n_2$ ,  
the first core layer being formed on the substrate;

a second core layer having a third refraction index  $n_3$ ,  
the second core layer being formed on the first core layer  
10 apart from the first core layer with a space  $d$  in between;

a first cladding layer having a fourth refraction index  
 $n_4$ , the first cladding layer being formed on the second core  
layer;

a second cladding layer having a fifth refraction index  
15  $n_5$ , the second cladding layer being formed on the first  
cladding layer and inserted between the first core layer and  
the second core layer; and

a Fresnel lens positioned on the second cladding layer,  
wherein the refractive indexes satisfies conditions of  
20  $n_5 > (n_2, n_3) > n_1$  and  $n_5 > n_4$ ; and light inputted through the first  
and second core layers to the Fresnel lens as radiated leaky  
beams by a leaky mode formed according to the conditions, and  
the leaky beams form an optical focus by performing single  
directional coupling towards the lower part of the substrate  
25 by using beams refracted from the Fresnel lens.

2. The focusing waveguide grating coupler as recited

in claim 1, wherein the length of the coupling is adjusted by controlling the space d.

3. The focusing waveguide grating coupler as recited  
5 in claim 1, wherein the amount of leak beams and a leaky angle are adjusted by controlling the refractive index  $n_4$  of the first cladding layer and the refractive index  $n_5$  of the second cladding layer.

10 4. The focusing waveguide grating coupler as recited in claim 1, wherein the focusing waveguide grating coupler is positioned on a plane formed of an x axis and a y axis and the optical focus is matched with a z axis.

15 5. The focusing waveguide grating coupler as recited in claim 4, wherein the space d are controlled to have the maximum leakage effect and leaky beams of Gaussian distribution in a range of  $\{b-L/2 < y < b+L/2\}$ , b denoting a distance between the input light and the center of the Fresnel  
20 lens and L denoting a diameter of the Fresnel lens.

6. The focusing waveguide grating coupler as recited in claim 1, wherein the second refraction index  $n_2$  and the third refraction index  $n_3$  are the same substantially.

25 7. The focusing waveguide grating coupler as recited in claim 1, wherein the fourth refraction index  $n_4$  is smaller

than the first refraction index  $n_1$  ( $n_1 > n_4$ ).

8. The focusing waveguide grating coupler as recited in claim 1, wherein the fourth refraction index  $n_4$  is larger than the second refraction index  $n_2$  and the third refraction index  $n_3$  ( $n_4 > n_2$  and  $n_4 > n_3$ ).